

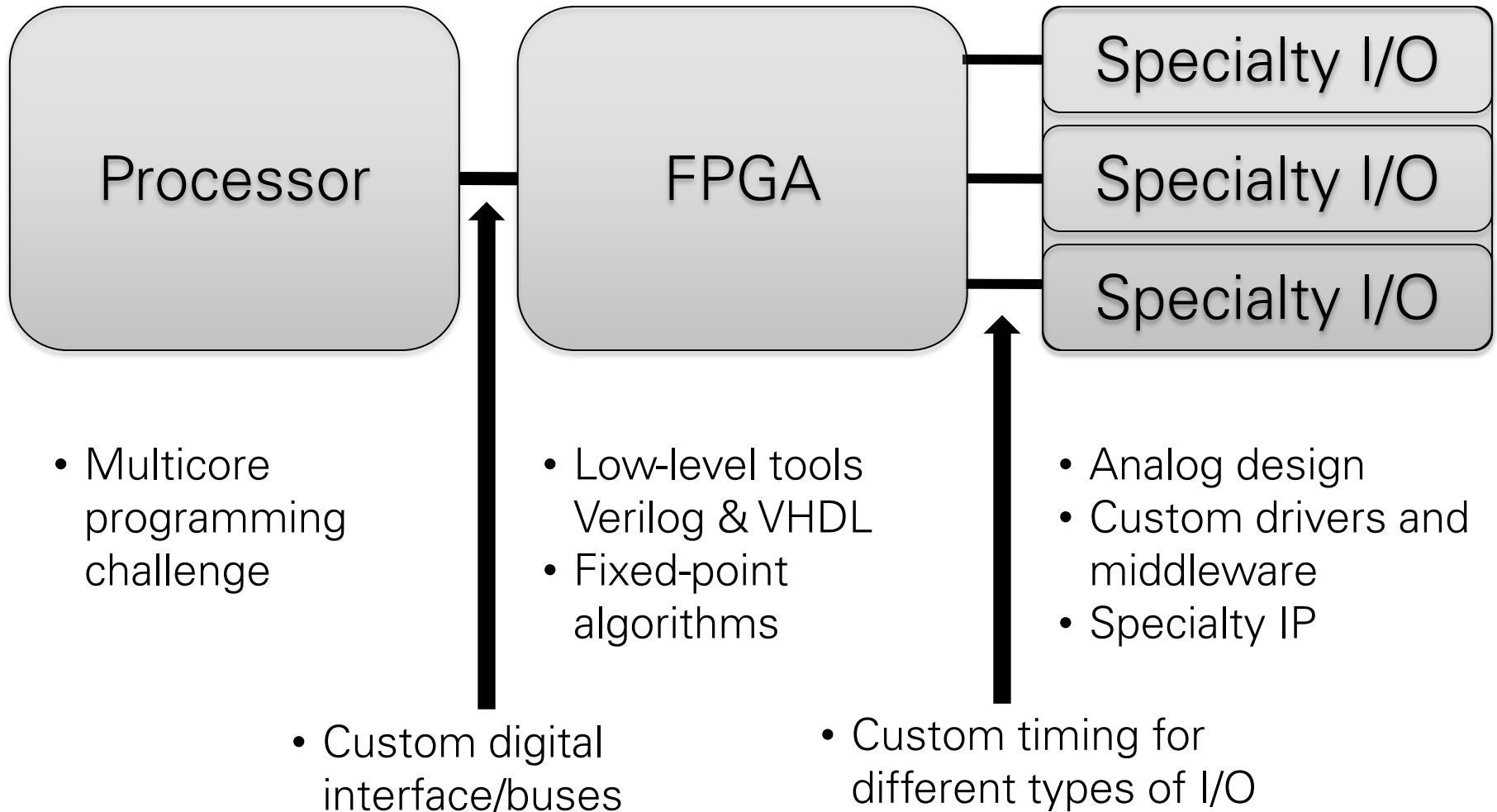
Introduction to LabVIEW RIO

Lawrence Berkeley National Lab – LabTech Day 2014

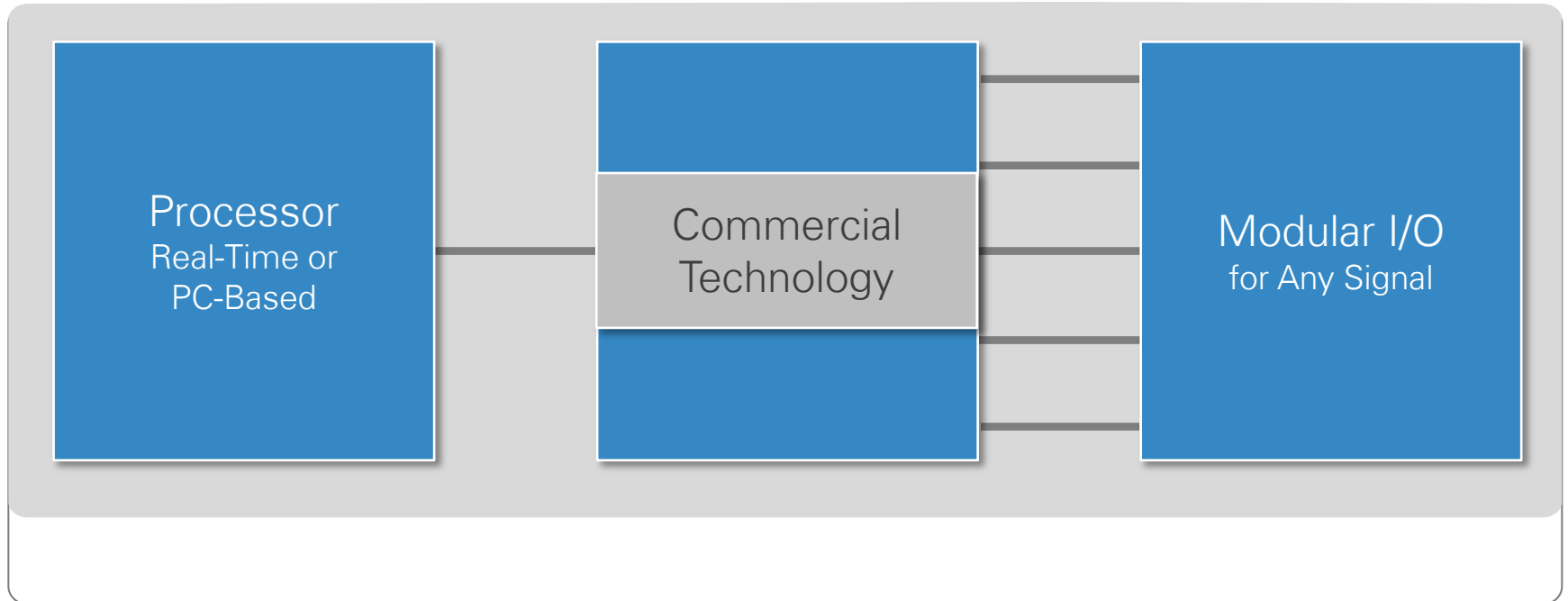
Chris Grabski

National Instruments – Field Engineer

The Challenge of the RIO Architecture

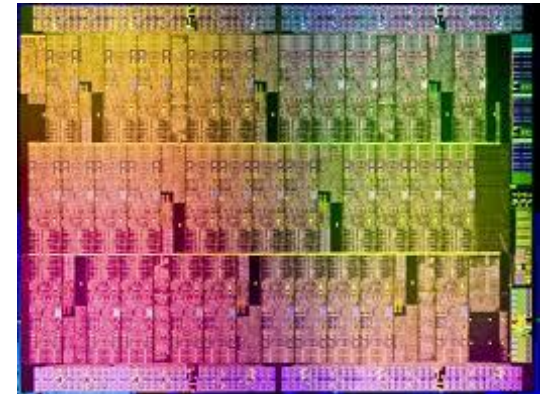


The NI Approach to Flexible Hardware



Importance of a Powerful Processor

- Full featured and flexible operating systems
- Rich communication options
- Floating point processing

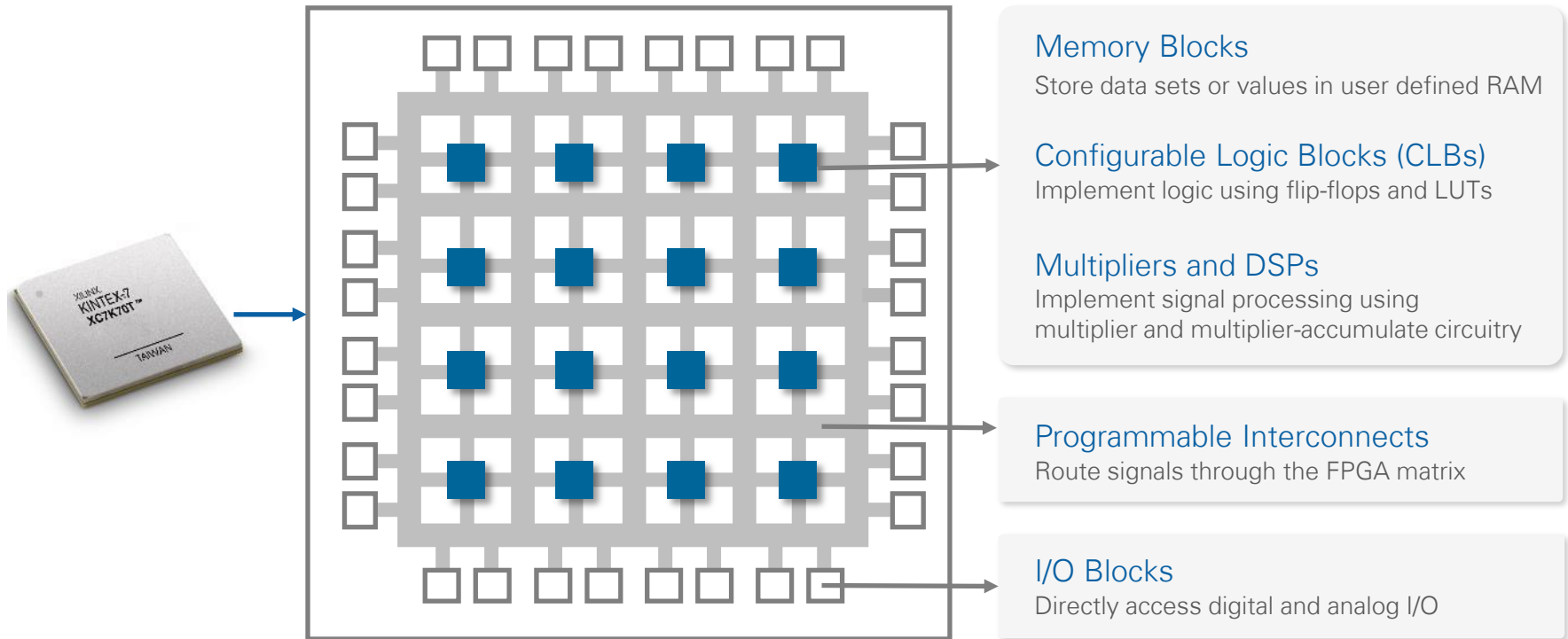


WIND RIVER

PowerPC[™]

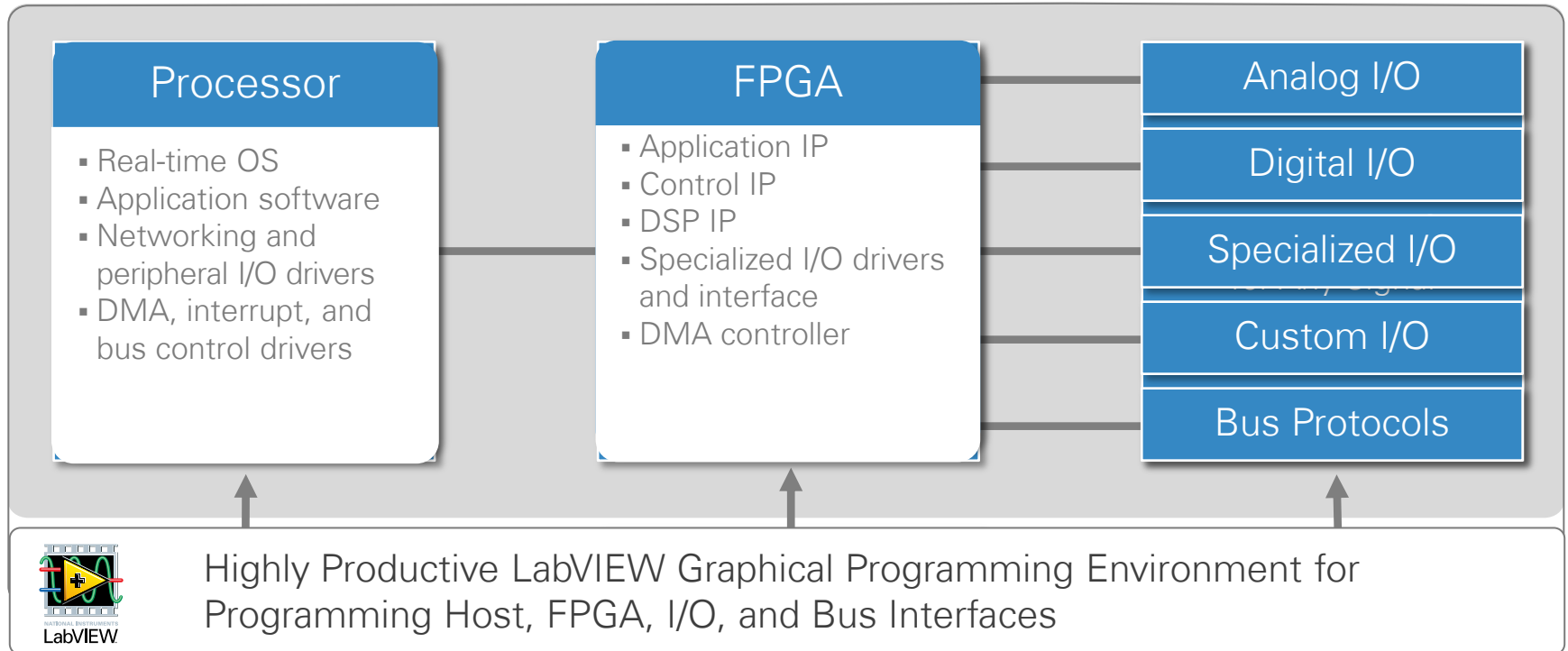


Field-Programmable Gate Array (FPGA)

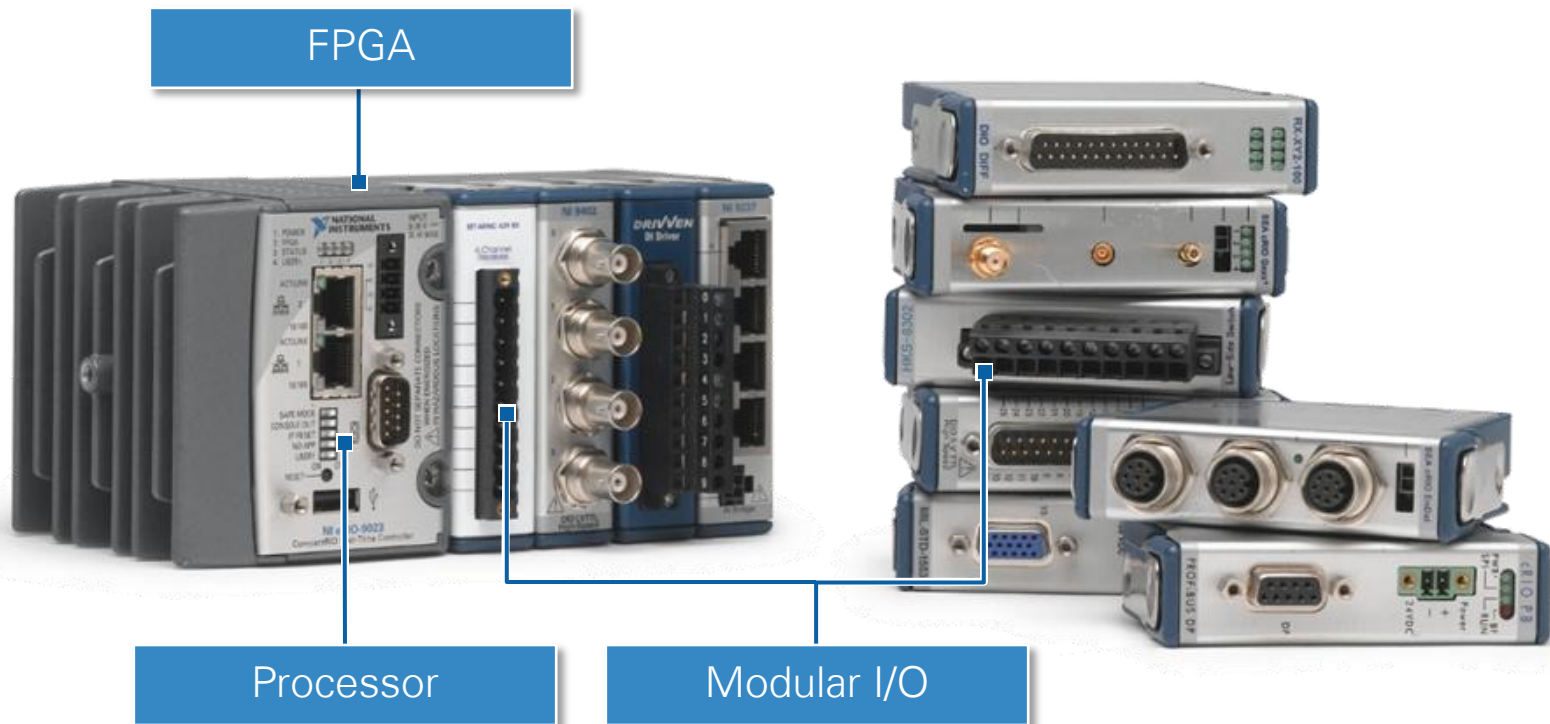


The NI Approach to Flexible Hardware

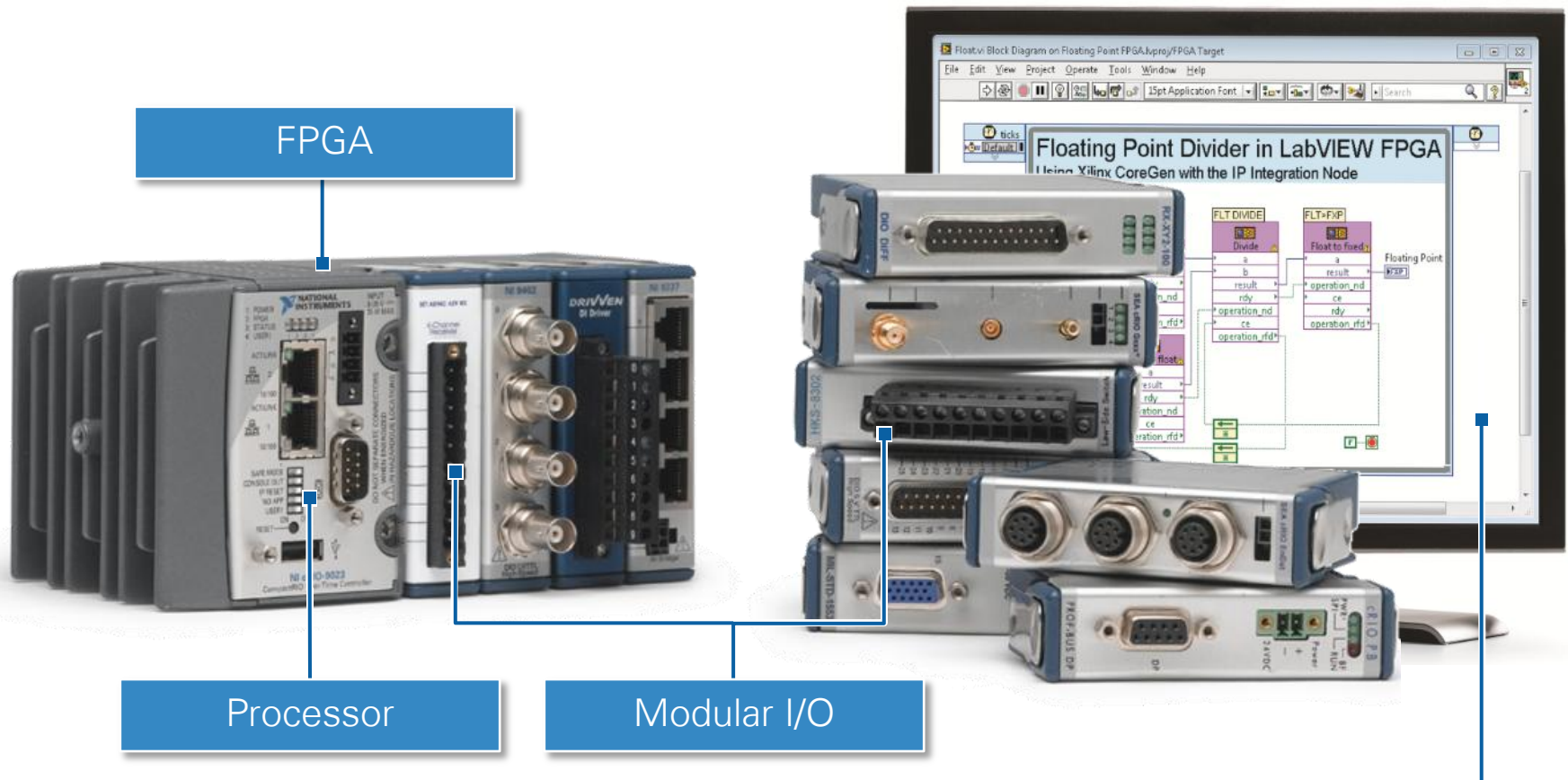
We call this the LabVIEW RIO Architecture.



NI CompactRIO



NI CompactRIO



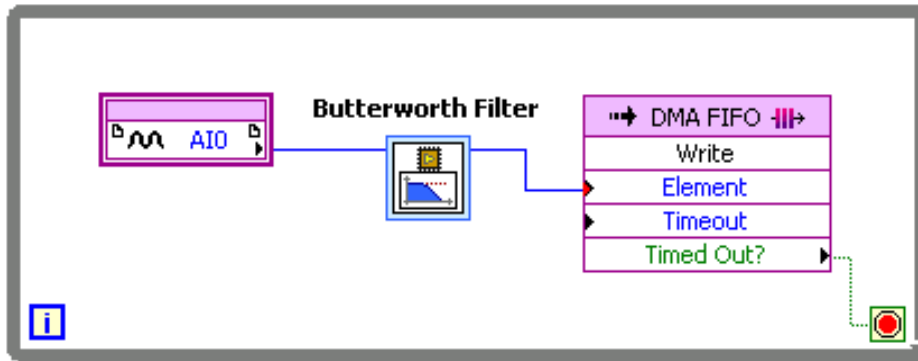
Extreme Ruggedness: -40 to 70 °C temperature range; 50 g shock, 5 g vibration
High Performance: Up to 1.33 GHz dual-core i7 processor
Comprehensive I/O: Analog, digital, custom, specialty, bus communication

LabVIEW FPGA Productivity & Abstraction

Counter

Analog I/O

I/O with DMA

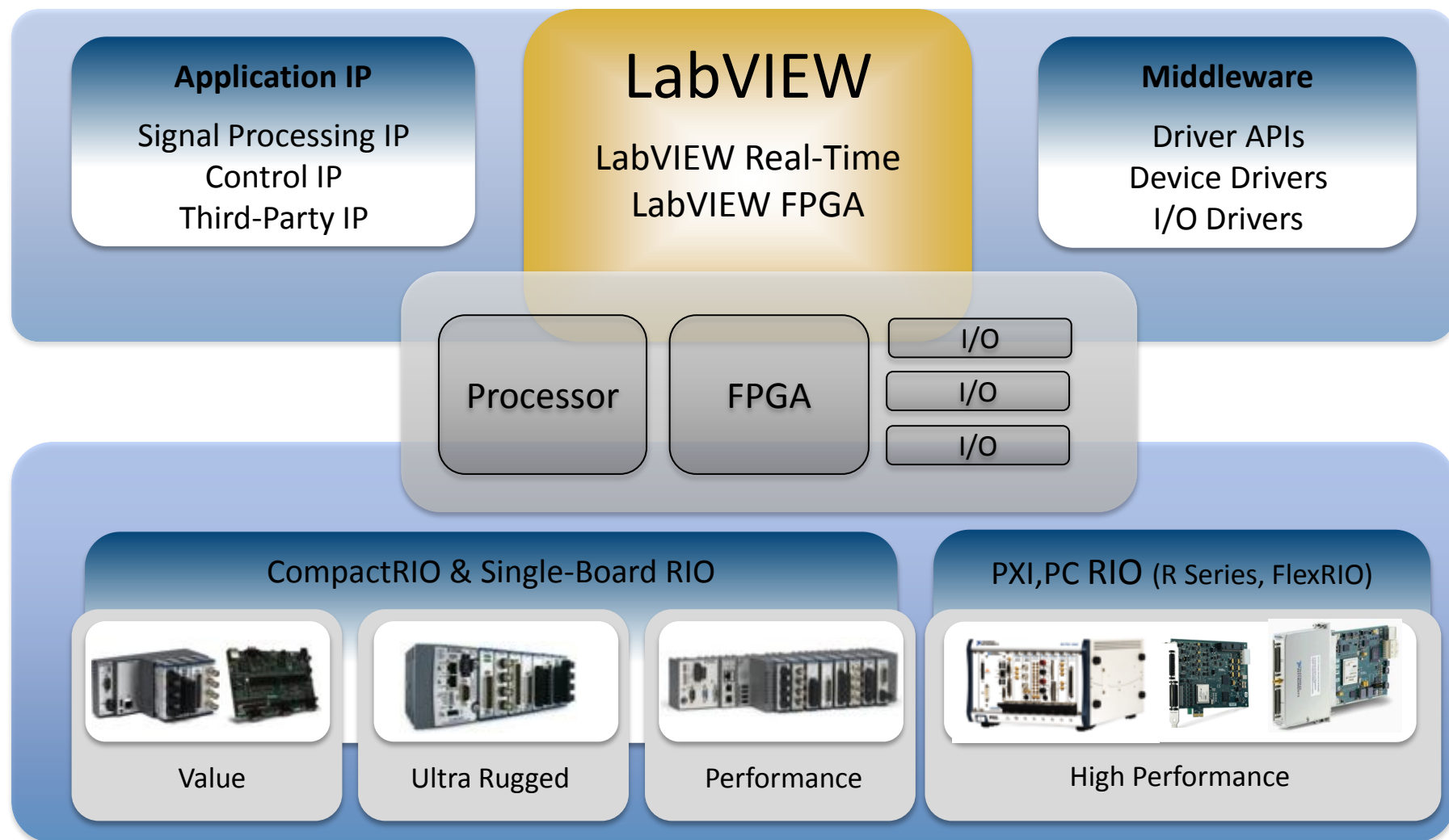


LabVIEW FPGA

[illegible]

VHDL ~4000 lines

LabVIEW RIO (Reconfigurable IO) Platform



NI RIO Technology Partner Advantage

Processor

- Intel, Microsoft, Freescale, Wind River
- Multi-core and real-time technology



Bus

- PCI/PCIe, Enet, USB, wireless, deterministic Enet
- Open architecture



FPGA

- Xilinx Virtex & Spartan
- Reconfigurable hardware



IP

- Control & signal processing IP & I/O drivers
- Built-in graphical IP, integrate existing IP



I/O

- Analog Devices, Texas Instruments
- Connect to any sensor & actuator



RIO Hardware Platform

CompactRIO & Single-Board RIO



Value



Ultra Rugged



Performance

PXI,PC RIO (R Series, FlexRIO)



High Performance

Expansion RIO



Ethernet RIO



EtherCAT RIO



MXI Express RIO

CompactRIO Hardware Platform

CompactRIO & Single-Board RIO



Value

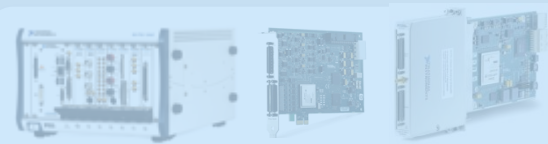


Ultra Rugged



Performance

PXI, PC RIO (R Series, FlexRIO)



High Performance

Expansion I/O



Ethernet RIO

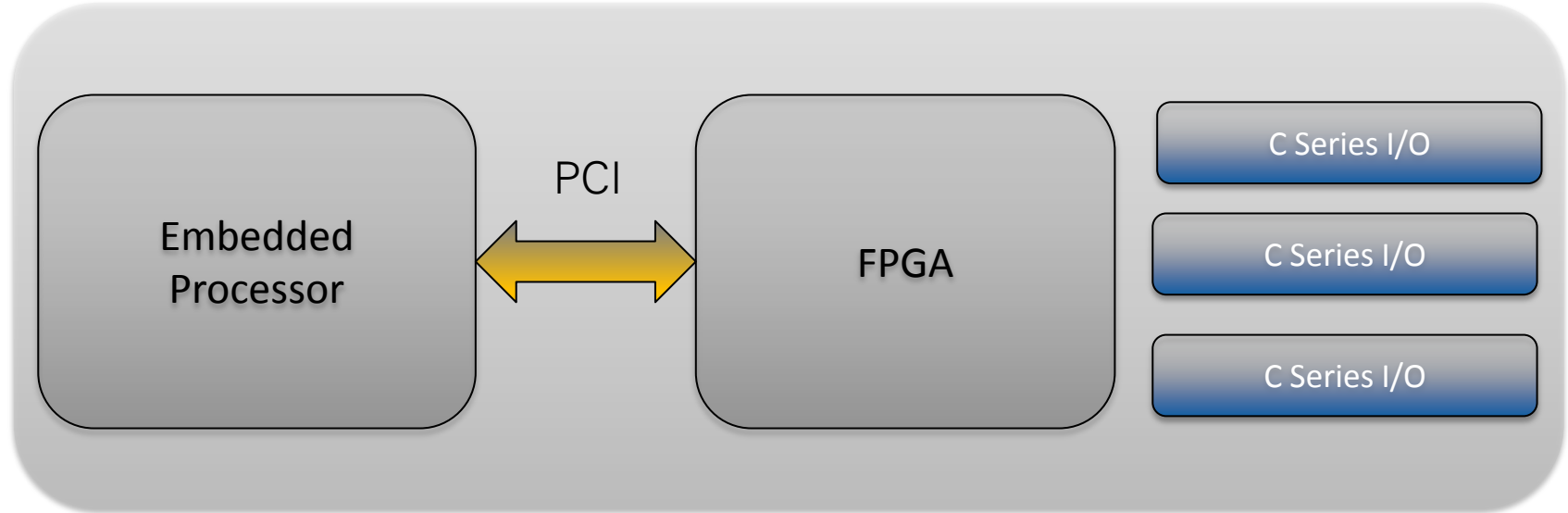


EtherCAT RIO



MXI Express RIO

What is CompactRIO



NI CompactRIO Components

Real Time Processor



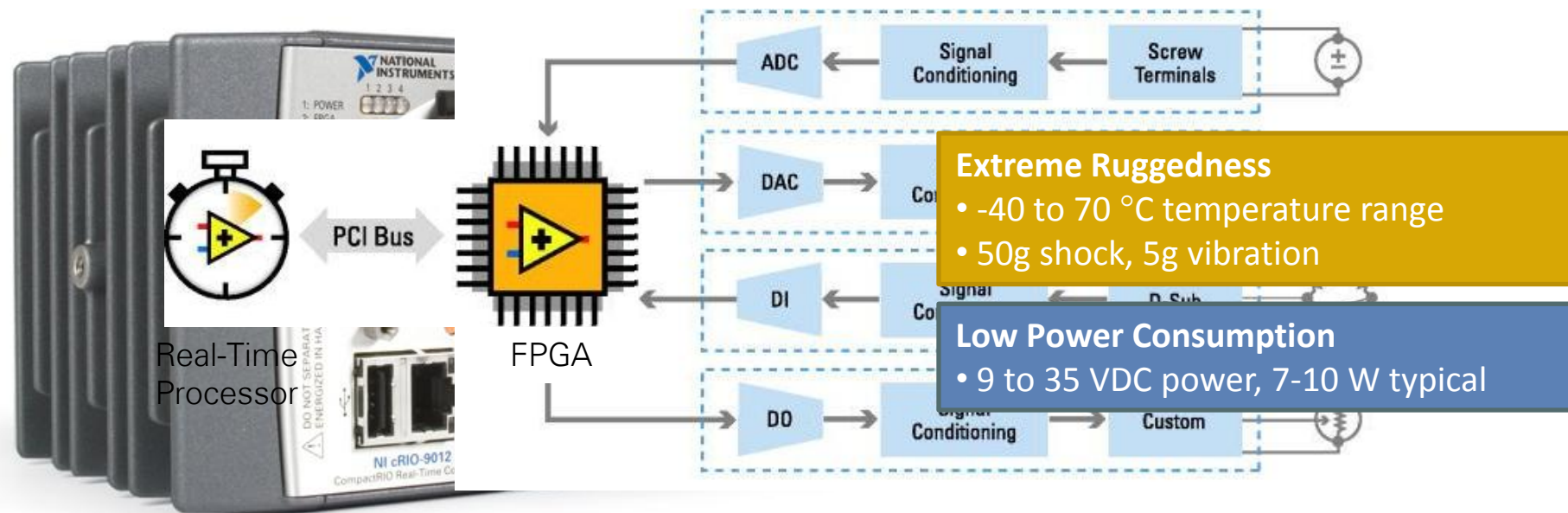
FPGA & Backplane



I/O Modules



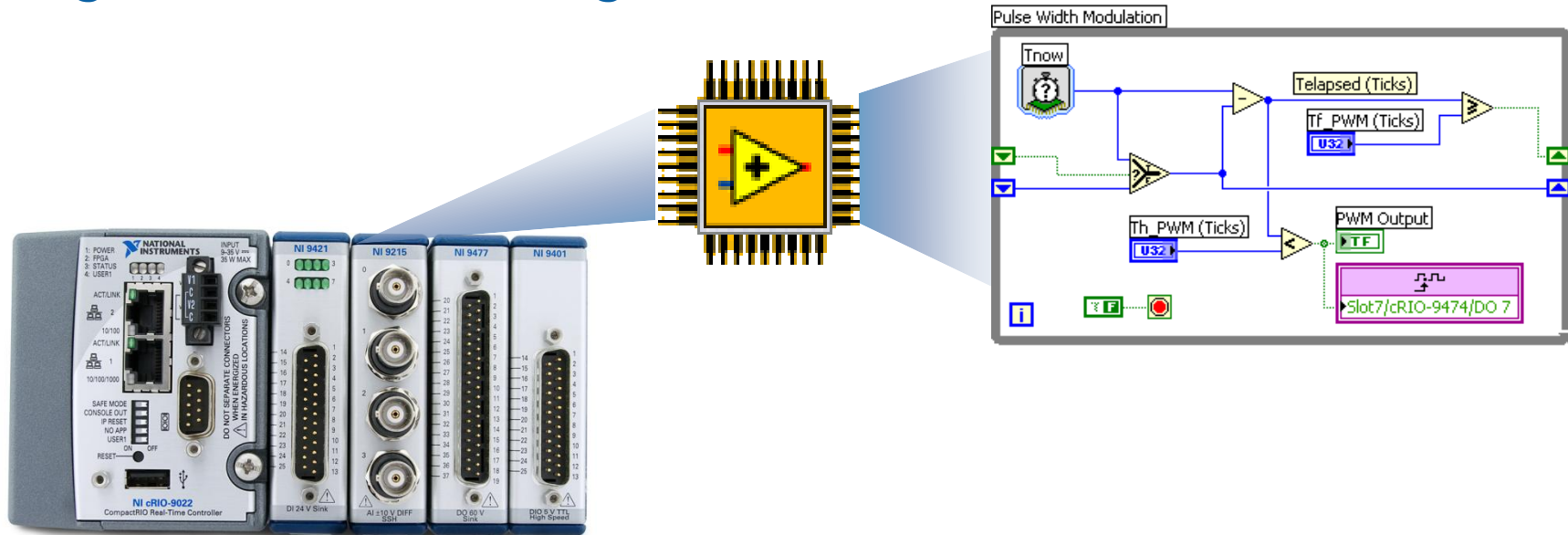
How It All Works Together



- **Reconfigurable FPGA** for high-speed and custom I/O timing, triggering, and control
- **I/O modules** with built-in signal conditioning for connection to sensors/actuators
- **Real-time processor** for reliable measurement, analysis, connectivity, and control

Reconfigurable I/O (RIO)

Using LabVIEW to design hardware



Replace custom circuitry with software-programmable FPGA logic

- High speed control (1 MHz digital / counter-timer, 200 kHz motion control / analog PID)
- Dedicated logic in silicon for highest reliability
- Intelligent DAQ (custom timing, triggering, synchronization, counter/timers, PWM)
- Digital signal processing (decoding and processing industrial sensor signals)

Demonstration

CompactRIO Hardware Overview



	Value	Ultra Rugged	Performance
Processor Performance	Up to 400MHz	Up to 800 MHz	Up to 1.33 GHz Dual-Core
FPGA Performance	Up to 43,661 logic cells, up to 58 multipliers	Up to 110,592 logic cells, up to 64 multipliers	Up to 147,443 logic cells, up to 180 multipliers
Analog I/O Speed	Up to 1 MHz	Up to 1 MHz	Up to 1 MHz
Operating System	Real-Time OS	Real-Time OS	Window/Real-Time OS
Ruggedness	-20 to 55° C*, passively cooled	-40 to 70° C, passively cooled	0 to 55° C, passively cooled
Size	Starts at 17.8x9.3x8.7 cm. ³	Starts at 18x9.3x8.7cm. ³	Starts at 40.4x10.5x8.7 cm. ³
Target Application Examples	<ul style="list-style-type: none"> • Smart grid analyzer • Environmental Monitoring <ul style="list-style-type: none"> • Mobile robotics • Medical diagnostics & device control • Special Purpose Machines (SPM) • Chemical Process Control • Wind Turbine Monitoring 	<ul style="list-style-type: none"> • In-vehicle logging • Machine Condition Monitoring • Industrial Machine Control <ul style="list-style-type: none"> • Oil & Gas Monitoring • Power Monitoring • Structural Monitoring • Automated Welding Control 	<ul style="list-style-type: none"> • Multi-axis Motion • Machine Vision • Power Distribution/Control <ul style="list-style-type: none"> • ECU Prototyping • Analytical Instruments <ul style="list-style-type: none"> • Turbine Control • Industrial Robotics • Big physics & research

PCI and PXI RIO Hardware Platforms

CompactRIO & Single-Board RIO



Value



Ultra Rugged



Performance

PXI, PC RIO (R Series, FlexRIO)



High Performance

Expansion I/O



Ethernet RIO

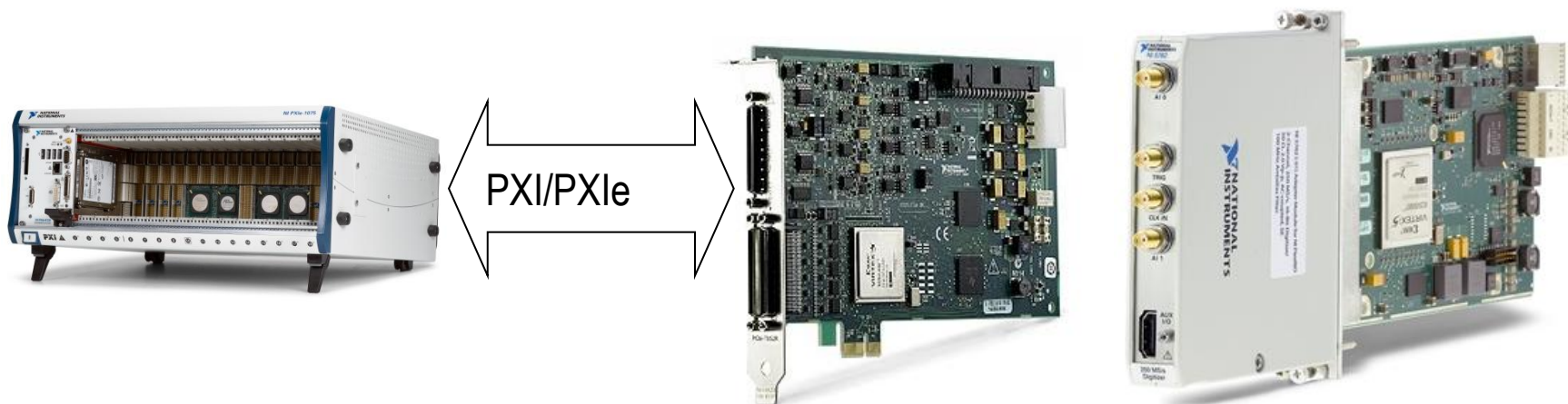
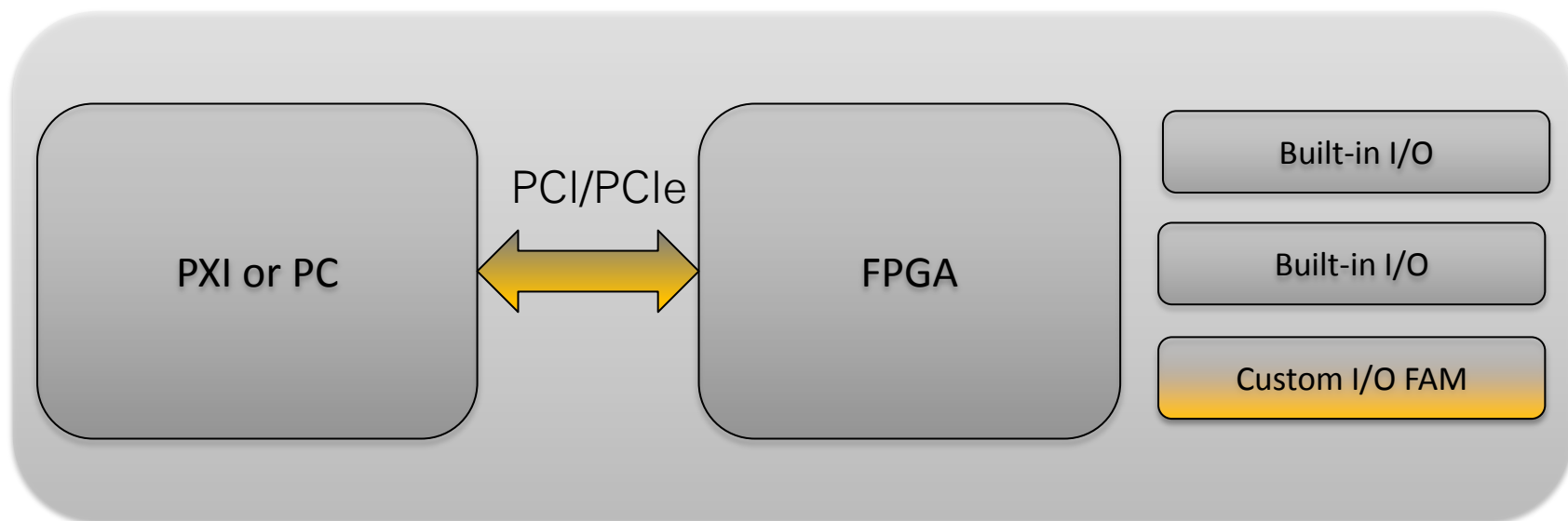


EtherCAT RIO



MXI Express RIO

What are R Series and FlexRIO



NI FlexRIO System Architecture



NI FlexRIO Adapter Module

- Interchangeable I/O
- Customizable by users
- NI FlexRIO Adapter Module Development Kit (MDK)

NI FlexRIO FPGA Module

- Virtex-5 FPGA
- 132 digital I/O lines
- Up to 512 MB of DRAM

PXI Platform

- Synchronization
- Clocking/triggers
- Power/cooling
- Data streaming at 800 MB/s

RIO Hardware Platform

CompactRIO & Single-Board RIO



Value



Ultra Rugged



Performance

PXI,PC RIO (R Series, FlexRIO)



High Performance

Expansion I/O



Ethernet RIO



EtherCAT RIO



MXI Express RIO

Questions